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Performance of collaborative forest management on forest status and contribution to adjacent community livelihoods in Uganda

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Abstract

It is prominently claimed that including the local community in forest management by adopting Collaborative Forest Management (CFM) approach could help for sustainable forest management. Therefore, information on its effectiveness is still needed for better planning in forest conservation. This study assessed the effectiveness of CFM on both forest status conditions and local community livelihoods in Mabira Central Forest Reserve (MCFR) in Uganda. A floristic survey was conducted to collect data on the species composition in the sites under CFM and Non-CFM. Also, interviews and focus group discussions were used to collect data on the socio-economic aspect of the adjacent local community. Forest species composition status was assessed using common alpha diversity indices (Species richness, Shannon Weiner index, and Simpson index), beta diversity (Jaccard Coefficient), structural vegetation parameters (tree density and basal area) and species Importance Value Index (IVI). Further, size class distribution was established for the two sites (CFM and Non-CFM). Regarding local community livelihood, descriptive and inferential statistics were used. Results revealed that the two sites have low similarity with the CFM site having low species diversity compared to Non-CFM site. The size class distribution of the site under CFM shows stable vegetation, suggesting good regeneration and recruitment potential. In contrary, the adjacent community livelihoods seemed to not be improved after the implementation of the CFM approach. Their income has considerably decreased because most of their activities were based on forest resources. We, therefore, argue that CFM approach should be updated and mixed with a top-down approach to improving forest status and local community livelihoods.

Key words: Collaborative Forest Management, forest conditions, livelihoods, local community, species diversity

Introduction

In developing countries, forest resources represent the major source of income for the surrounding population (Chirwa *et al*., 2008; Wunder *et al*., 2014; Jannat *et al.*, 2018). They play a critical role in supporting the livelihood of people worldwide, particularly in meeting the daily subsistence needs of the world's poor (UNEP, 2007). For several decades, these natural forests have been managed based on a command and control system which excluded local communities in decision making and also limited their access to forest resources (Raphael and Swai 2009; Turyahabwe *et al*., 2012). However, these forest areas continue experiencing increasing degradation and deforestation. The major causes of this rapid forest cover loss have been mostly the conversion of forest land to other land use types such as agriculture and urbanization but also to some practices like rampant felling of trees for firewood, charcoal burning as well as issues relating to governance in the forestry sector (National Forestry Authority, 2015). The 1992, International Earth Summit in Rio de Janeiro in Brazil on sustainable natural resource management led to the recognition of the role of local communities in natural resources management and in the revision of forest policies in many countries (UNCED, 1992; Jumbe and Angelsen, 2007). Proponents of the participatory approaches appealed that participation would give the poor' a voice and a choice (Cornwall, 2006).

Article 13 and Article 27 of Uganda's 1995 Constitution provides for the protection and the sustainable management of natural resources. Therefore, in 1997, the government of Uganda opted for more a participatory approach in the management and utilization of natural forests. These approaches allowed all stakeholders especially local communities who have a direct stake in forest resources to be part of decision-making in all aspects of forest management, from managing resources to formulating and implementing institutional frameworks (Turyahabwe et al., 2012). Among these approaches the famous ones are Community Based Forest Management (CBFM), Joint Forest Management (JFM) and Collaborative Forest Management (CFM) the widely used in Uganda. In Mabira Central Forest Reserve (MCFR), the CFM approach has been implemented in the production zone for the past two decades by the Ministry of Water and Environment and the National Forestry Authority of Uganda (MWE, 2017). According to the Uganda National Forestry and Tree Planting Act, the CFM approach is expected to reduce conflicts between government and forest adjacent communities, establish fair terms for access rights and the distribution of benefits, responsibilities, and decision-making in forests, ensure fair distribution of the costs of forest management, enable sharing knowledge and skills between responsible bodies and create a sense of ownership and promote local people's security of tenure over forest resources (MWE, 2017).

The same approach is used in different countries with different terminologies but with similar connotations. In Eastern and Southern Africa, CFM is named co-management whereas in Benin it is called participatory management approach, community forestry in Nepal and joint forest management in India and Brazil. CFM is defined as a working partnership between the key stakeholders such as forest user groups and a responsible body in which, roles, responsibilities, rights and returns (benefits) for sustainable management of given forest resources are shared– the '4R' framework (Carter, 2005; MWE, 2017; Crescent and Naguru, 2018).

The main aim of this approach is intended to contribute to the sustainable management of forest products and at the same time improving the livelihoods of the adjacent local community (Gobeze *et al*., 2009). Sociologically, livelihood is defined as the means, activities, capabilities, assets, and access that jointly determine the living gained by an individual or household, and can be applied to explore how a certain event or 'shock' can lead to different livelihood outcomes (Ellis, 1998; DFID, 1999). One of the key requirements of CFM is the establishment of robust community institutions that ensure transparent decision making, adequate representation and participation of women, men and vulnerable groups, and the equitable sharing of forest benefits as well as responsibilities.

Despite the increasing number of studies on the effectiveness of CFM on both local community livelihoods and the conservation of forest resources (Phiri *et al*., 2012; Siraj *et al*., 2016; Gandji *et al*., 2017; Rai *et al*., 2017; Waridin *et al*., 2019), there is still a lack of consensus in the findings. While findings from some of these studies (Turyahabwe *et al*., 2013) reported that CFM can improve forest status and provide economic benefits to the surrounding local communities (Chinangwa *et al.*, 2016; Waridin *et al*., 2019), some argue that CFM does not guarantee the success of forest resources conservation (Rasolofoson *et al*., 2015) and equitable distribution of benefits (Paswan *et al*., 2019). Recent assessments in Kasyoha, Kitomi and Echuya central forest reserves in Uganda have however revealed that CFM contributes enormously towards responsible management of the forest resources and reduced over dependence of the local communities on sourcing forest products from the forest reserve (Crescent and Naguru, 2018). Nevertheless, it remains unclear whether these findings apply to the rest of the forest reserves in Uganda which have benefited from this approach. Owing to that, this present study assessed the performance of CFM approach on the forest status conditions as well as its impacts on local community livelihoods in MCFR, one of the largest natural forest reserves areas in Uganda (Olupot and Sande, 2019). In this study, we tested the hypothesis that (1) CFM approach would improve MCFR status conditions by limiting human incidence to the forest but also enhance the regeneration of tree species and (2) CFM would improve local community livelihoods by increasing their incomes, savings and social networking.

Materials and methods

Study area

Mabira Central Forest Reserve (MCFR), 31,293 ha in size covers 3 districts; Buikwe, Mukono and Kayunga (Fungo, 2013) . It is located approximately 60 km east of the capital, Kampala and situated between latitude 0° 22'and 00 35' N and 30° 56' and 33° 02'East. MCFR was gazetted as a Central Forest Reserve in the 1900 under the Buganda agreement. It has been protected as a Forest Reserve since 1932 and is currently managed by the National Forest Authority (NFA) under a plan that partitions it into three zones (Jjagwe *et al*., 2020). The inner zone is "strict nature reserve" in which no activities are permitted except scientific research and law enforcement. The outer zone is comprised of a "buffer zone" and a "production zone" (Olupot and Sande, 2019). The climate is an equatorial type characterized by a bimodal pattern of rainfall with two wet seasons, March-May and September-November. The mean annual temperature is about 21-25 °C. According to Baranga (2007), approximately 47% of Uganda's tree species grow in MCFR. In 2002, the population density within 2 km of MCFR was 302 inhabitants/km^2 (Weldemariam *et al.*, 2017).

Within the forest, there are also 27 villages commonly known as enclaves, where subsistence farming is the primary activity for the 3,506 families within (Baranga, 2007). The surrounding community is mostly involved in some illegal activities like charcoal burning, pit sawing and collection of poles for construction as well as collecting medicinal plants mainly for their local use. The forest reserve receives more than 62% of all tourists visiting the country (Weldemariam *et al*., 2017). The soils belong to the ferrallitic types which are the final stage of tropical weathering. The topography of the forest is characterized by gently undulating plateau from flat topped hills to wide shallow valleys occupied by swamps. The vegetation of MCFR was classified as "medium altitude moist semi-deciduous" (Hamilton, 1974) but the forest has greatly been influenced by human activities (i.e. exploitation, cultivation

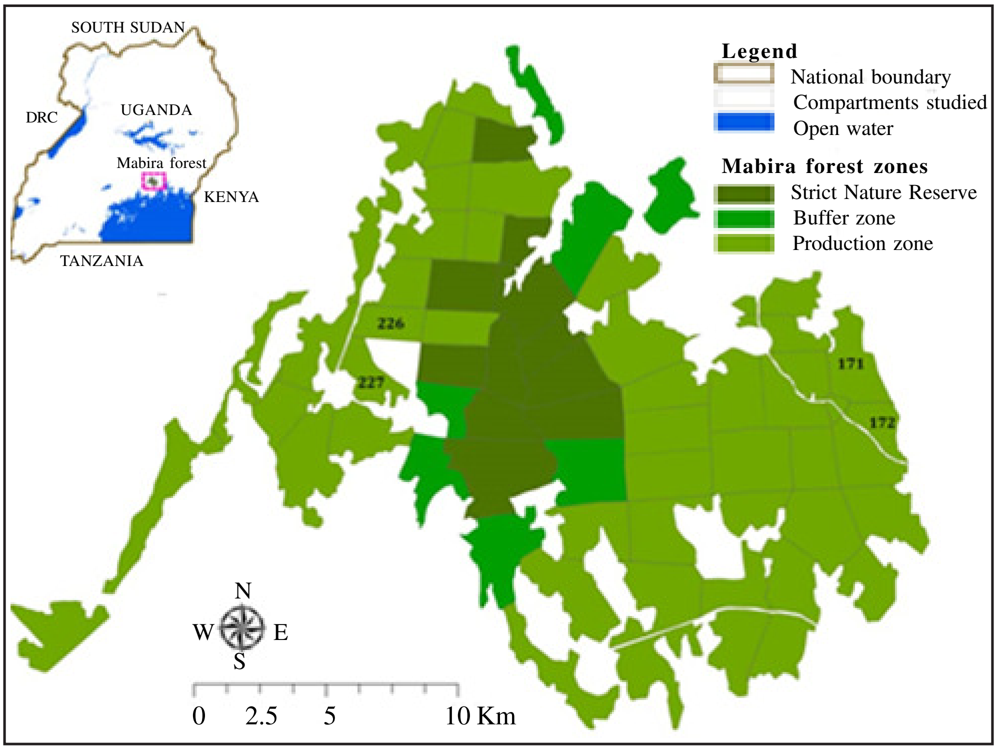

Figure 1. Map of the study area.

and grazing) for a long time that it is regarded as secondary forest resulting from and constantly being influenced by such activities.

Sampling design, tree species composition determination and assessment of local community livelihoods

Among the three zones that constitute MCFR, the study was conducted in the production zone. This is justified by the fact that the CFM approach is only being implemented in this zone. To assess the impact of CFM approach on the vegetation status of MCFR, four compartments were randomly selected under the production zone. The selected compartments have an average size of 400ha each and included compartments 171 and 172 under CFM approach, and non-CFM compartments 226 and 227 for comparison. In total, four transect lines were established in the four compartments and each started at 100m from the boundary to limit the edge effect in each compartment. Between two vegetation plots, the distance was 20m. Along each transect, 7 to 8 plots were systematically laid out in 20m*10m plots. In total, 30 plots were laid out in the entire study area. Within each of these plots, stratification (nesting plot method) was done to include small plots with size 10m*5m and 5m*2m for recording saplings and seedlings, respectively. Plants with Diameter at Breast Height (DBH) varying between 0-3, 3-10 and above 10 were considered as seedlings, saplings and trees, respectively. In each plot, data on geographical coordinates, plant tree species (*local or scientific names if available*) and DBH measurements were recorded.

Observational methods were used to identify anthropogenic activities that are taking place in plots under CFM and non-CFM, the most common forms of which include timber cutting; firewood harvesting; charcoal burning; grazing of livestock; and encroachment for agriculture (Turyahabwe *et al.*, 2013).

With regard to local community livelihoods, 60 households were randomly selected in total at the rate of 30 households per village for interview. These villages are Bulyansi (Non-CFM site) and Buvunya (CFM site) enclave. Both structured interview and focus group discussion (8 respondents) were done in June 2019 using a questionnaire and semi-structured questionnaire, respectively. Data collected included socio-demographic characteristics, self-reported variations in income levels, income sources, asset accumulation, and accessibility to forest products.

Data analysis

All analyses were done in R statistical software package, version 4.0.3. Prior to all these analyses, we used MINITAB 14 to organize the data in such a way that it respects R software requirements for biodiversity analyses. Taxonomic diversity (species richness, Shannon Weiner Index, Shannon Evenness and Simpson Index) were assessed following Magurran, (1988). The assessment of floristic composition was done by combining the relative values of structural variables such as stand density (N, trees Ha^{-1}), basal area ($G.m^2$), species frequency to determine the Importance Value Index (IVI) which is an indicator of a species relative ecological importance (Curtis and McIntosh, 1951; Bekele, 2018) .

Tree density was computed as the number of trees per hectare, and basal area as the sum of the cross-sectional area 1.3 m above. Further, Size Class Distribution is also important in understanding the dynamics of forest stand (Mensah *et al.*, 2018). In that line, we established the overall size class for the two sites (CFM and Non-CFM). The assessment of similarities between the two sites were done using Jaccard Coefficient Index. To investigate how the species richness increases according to the sampling efforts and data variability, we established species accumulation curves for the two sites using Biodiversity R package. To test the difference of mean values of different parameters, one way Analysis of Variance (ANOVA) was applied to log-transformed data (log (x + 1)).

Concerning the local livelihood assessment, both descriptive and inferential statistics, radar plots and bar plots were used to explain the influence of the implementation of CFM approach on adjacent community both near CFM site and Non-CFM.

Results

Forest status conditions

Species composition and diversity across sites
A total of 777 individuals belonging to 48 tree species and 26 families were recorded in the study area. Out of these 48 tree species, 15 were found to be common to both sites (Non-CFM and CFM). Twenty-eight were identified to be associated with only Non-CFM whereas five tree species were found to be associated with only CFM (Table 1). The Shannon Weiner Index was significantly lower ($F=88.37$; $P<0.001$) for CFM site compared to the non-CFM site. This trend is also supported by the Simpson Diversity Index with 0.89 and 0. 39 for Non-CFM and CFM, respectively. However, the one-way ANOVA test revealed no significant difference between the Shannon Equitability Index of the two sites (Fig. 2a). In terms of similarity, the Jaccard coefficient (0.39) of similarity revealed low resemblance between the two sites. Further analysis also showed that the number of species per plot for small (DBH < 10), medium (DBH < 20) and large (DBH < 30) trees was significantly higher in the case of Non-CFM compared to the CFM site (Fig. 2b).

Table 1. Number of individuals, species richness, species and family associated with each site

Sites	Number of individuals	Species richness	Number of species only associated with Non-CFM	Number of family only associated with CFM
Non-CFM	563	43	28	12
CFM	214	20	5	2

The species accumulation curve of the Non-CFM site reached its asymptote which suggests that there is no much variabilities of tree species recorded and structural parameters among the different vegetation plots set in the site (Fig. 3). However, the lowest rate of species accumulation is observed for CFM site, which also reflected the lowest species richness and higher variability of data recorded in each of the plot. Across the two sites *Broussonetia papyrifera* is the most dominant tree species with IVI of 40.16 and 195. 5 for Non-CFM and CFM site whereas the least dominant

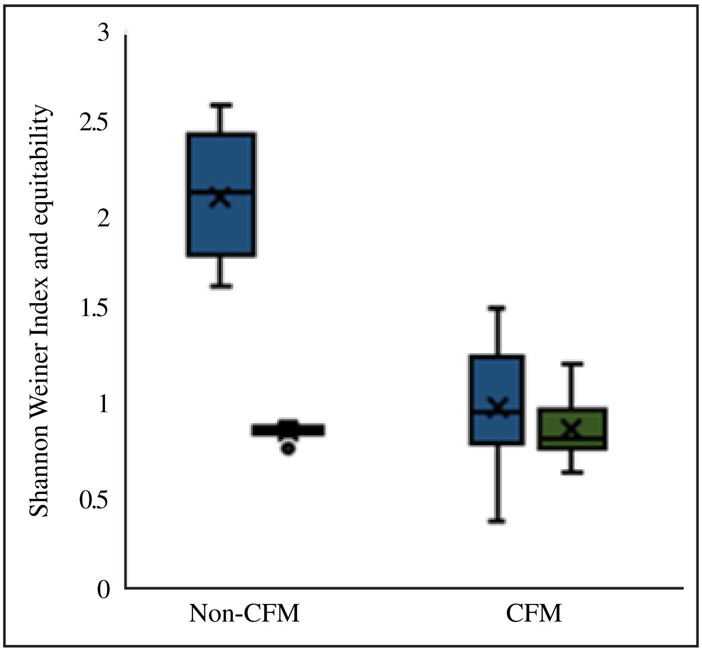

Figure 2(a). Shannon Weiner Index and equitability across the two sites.

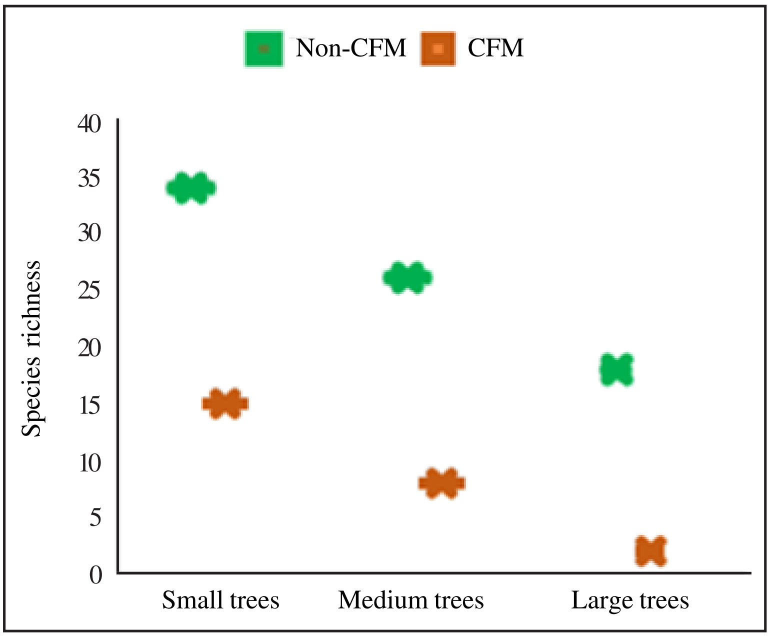

Figure 2(b). Species richness variation among large, medium and small trees in the two sites.

tree species are *Blighia welwitschii and Albizia ferruginea,* respectively (Table 2). The CFM site is mostly dominated by *Broussonetia papyrifera* which decreases the dominance rate of other tree species such as *Celtis mildbraedii, Teclea nobilis, Markhamia lutea* and *Oxyanthus speciosus,* which have very low IVI values.

Stem diameter structure and structural parameters across the two sites

The overall size class distribution of both sites exhibited an inverted-J shape curve while only the site under CFM shows several gaps in diameters classes beyond 30 cm (Fig. 4). Further, the figure shows a high number of young individuals tree species belonging to lower DBH classes (0-5; 5-10 and 10-15) and a gradual decrease from lower to higher size classes for both sites. It is also noticed that Non-CFM site has the highest number of young individual tree species compared to the site under CFM which might explain its stability.

The mean values and the coefficients of variation of structural parameters in each site are mentioned in Table 3. With regard to mean tree density, they were 535 stems. and 654.65 stems. for Non-CFM and CFM sites, respectively. These means do not vary significantly across the two sites (P-value=0.069). However, the mean DBH and the basal area varied significantly (P-value=0.035; P-value=0.011) across the two sites with Non-CFM having the highest mean value of DBH (12.38) and basal area (15.8). These results might suggest that the big tree individuals on site under CFM experience higher disturbance due to anthropogenic activities compared to Non-CFM which may probably led to their low number.

Local community livelihoods

Local perceptions of Collaborative Forest Management

Over the two villages, most of the respondents interviewed were adults (70.03%) and about 61.02 % of them were men. More than half had no formal education and 80.62% are farmers. In Buvunya, village adjacent to CFM site, 60% stated that life is getting harder and worse or perceived that their livelihoods have declined compared to the former management of the forest. On the other hand, 20% of interviewees do not perceive any change regarding their livelihoods level whereas only 10% have perceived improvement and the remainder are neutral about their livelihoods level change (Fig. 5). One of the female respondents in Buvunya village stated that: *"Since CFM has started with many rules, we are not allowed to get into the forest to get fuelwood for selling, things have changed"*. Further, a male interviewee said that: *"It is difficult for us to survive with our families because we mostly relied on the forest products but now, we can't access them easily"*. These findings showed that the local community livelihoods are mostly based on forest resources which are actually affected by the regulations of the CFM approach.

Table 2. Species names and Importance Value Index (IVI

Family	Species names	RF	RD	ORD	IVI
Non-CFM					
Moraceae	*Broussonetia papyrifera (L.) Vent*	5.19	9.22	25.75	40.16
Cannabaceae	*Celtis mildbraedii Engl.*	7.26	11.58	11.37	30.21
Apocynaceae	*Funtumia elastica (P. Preuss) Stapf*	6.23	9.04	12.97	28.23
Moraceae	*Antiaris toxicaria Lesch.*	4.15	17.93	3.20	25.27
Moraceae	*Bosqueia phoberos Baill.*	6.23	6.02	7.99	20.24
Fabaceae	*Dichrostachys cinerea (L.) Wight & Arn.*	3.63	9.77	1.60	15.00
Meliaceae	*Trichilia rubescens Oliv.*	5.71	2.00	4.09	11.80
Podocarpaceae	*Podocarpus usambarensis Pilger ex Engler*	0.52	9.25	0.18	9.95
Sapotaceae	*Aningeria spp*	5.19	0.77	3.73	9.69
Fabaceae	*Albizia zygia (DC.) J.F.Macbr.*	4.15	2.07	2.13	8.35
Ulmaceae	*Holoptelea grandis (Hutch.) Mildbr.*	2.29	3.85	1.07	7.51
Rosaceae	*Prunus Africana* Kalkman	1.04	5.87	0.36	7.26
Ebenaceae	*Diospyros abyssinica* F. White	4.15	0.77	2.31	7.23
Rutaceae	*Teclea nobilis Del.*	3.63	0.31	3.20	7.14
Meliaceae	*Trichilia dregeana Harv.& Sond.*	2.08	3.20	1.07	6.34
Sapindaceae	*Blighia unijugate Baker*	3.11	0.34	2.31	5.76
Rubiaceae	*Oxyanthus speciosus DC.*	3.11	0.10	2.49	5.70
Ulmaceae	*Celtis durandii Engl.*	3.11	1.15	1.07	5.33
Meliaceae	*Khaya anthotheca (Welw.) C. DC.*	3.11	0.72	1.07	4.90
Cannabaceae	*Celtis Africana Burm.f.*	2.59	1.19	0.89	4.67
Phyllanthaceae	*Bridelia micrantha (Hochst.) Baill.*	1.04	2.96	0.36	4.35
Apocynaceae	*Tabernaemontana holstii K.Schum*	3.11	0.16	1.07	4.33

Table 2. Contd.

Family	Species names	RF	RD	ORD	IVI
Phyllanthaceae	*Margaritaria discoidea (BAILL.) G.L. WEBSTER*	2.08	0.52	1.24	3.84
Bignoniaceae	*Markhamia lutea (Benth.) K. Schum.*	2.08	0.28	1.07	3.42
Sapotaceae	*Mimusops bagshawei S. Moore*	2.08	0.08	1.07	3.22
Annonaceae	*Monodora myristica (GAERTN.) DUNAL*	2.08	0.01	0.89	2.97
Sterculiaceae	*Cola gigantea A.CHEV.*	1.56	0.00	0.71	2.27
Fabaceae	*Albizia gummifera (J.F.Gmel.) C.A.Sm.*	1.04	0.01	0.36	1.41
Cannabaceae	*Celtis zenkeri Engl.*	1.04	0.01	0.36	1.40
Acanthaceae	*Justicia heterocarpa T. Anders.*	1.04	0.00	0.36	1.40
Urticaceae	*Musanga cecropioides R.Br. ex Tedlie*	0.23	0.18	0.89	1.30
Ulmaceae	*Celtis wightii Planch.*	0.52	0.21	0.36	1.08
Balanitaceae	*Balanites wilsoniana Dave & Sprague*	0.52	0.02	0.36	0.89
Fabaceae	*Tamarindus indica L.*	0.52	0.09	0.18	0.78
Moraceae	*Ficus mucuso Welw. ex Ficalho*	0.16	0.09	0.53	0.78
Sapotaceae	*Aningeria robusta A.Chev.*	0.52	0.08	0.18	0.78
Rhamnaceae	*Maesopsis eminii Engl*	0.52	0.07	0.18	0.77
Caesalpiniaceae	*Baikiaea insignis Benth.*	0.52	0.07	0.18	0.76
Moraceae	*Milicia excelsa (Welw.) C.C. Berg*	0.52	0.00	0.18	0.70
Oleaceae	*Olea welwitschia* Gilg. Schellenb	0.52	0.00	0.18	0.70
Moraceae	*Ficus capensis Thunb*	0.52	0.00	0.18	0.70
Euphorbiaceae	*Sapium ellipticum (Hochst.) Pax*	0.52	0.00	0.18	0.70
Sapindaceae	*Blighia welwitschia (Hiern) Radlk*	0.52	0.00	0.18	0.70

Table 2. Contd.

Family	Species names	RF	RD	ORD	IVI
CFM					
Moraceae	*Broussonetia papyrifera (L.) Vent*	28.85	89.08	7.57	195.50
Cannabaceae	*Celtis mildbraedii Engl.*	9.62	2.46	2.80	14.87
rubiaceae	*Teclea nobilis Del.*	5.77	0.72	2.34	8.82
Bignoniaceae	*Markhamia lutea (Benth.) K. Schum.*	5.77	0.07	2.34	8.18
Rubiaceae	*Oxyanthus speciosus DC.*	5.77	0.16	1.87	7.80
Meliaceae	*Khaya anthotheca (Welw.) C. DC.*	5.77	0.04	1.87	7.68
Phyllanthaceae	*Margaritaria discoidea (BAILL.) G.L. WEBSTER*	3.85	1.79	1.40	7.04
Apocynaceae	*Funtumia elastica (P.Preuss) Stapf*	3.85	0.67	1.40	5.91
Acanthaceae	*Justicia heterocarpa T. Anders.*	3.85	0.49	1.40	5.73
Fabaceae	*Albizia zygia (DC.) J.F.Macbr.*	3.85	0.22	0.93	5.00
Bignoniaceae	*Spathodea campanulate P. Beauv.*	3.85	0.20	0.93	4.98
meliaceae	*Trichilia rubescens Oliv.*	3.85	0.10	0.93	4.88
Burseraceae	*Canarium schweinfurthii Engl*	1.92	1.85	0.47	4.24
Sapotaceae	*Pachystela brevipes (Baker) Engl*	1.92	0.83	0.47	3.22
Flacourtiaceae	*Trimeria grandifolia (Hochst.) Warb.*	1.92	0.12	0.93	2.97
Ulmaceae	*Celtis durandii Engl.*	1.92	0.53	0.47	2.92
sapindaceae	*Blighia unijugate Baker*	1.92	0.29	0.47	2.68
Moraceae	*Bosqueia phoberos Baill.*	1.92	0.29	0.47	2.68
Fabaceae	*Dichrostachys cinerea (L.) Wight & Am.*	1.92	0.09	0.47	2.48
Fabaceae	*Albizia ferruginea (Guill. & Perr.) Benth.*	1.92	0.01	0.47	2.41

RF: Relative Frequency, RDo: Relative Dominance, RD: Relative Density, IVI: Importance Value Index

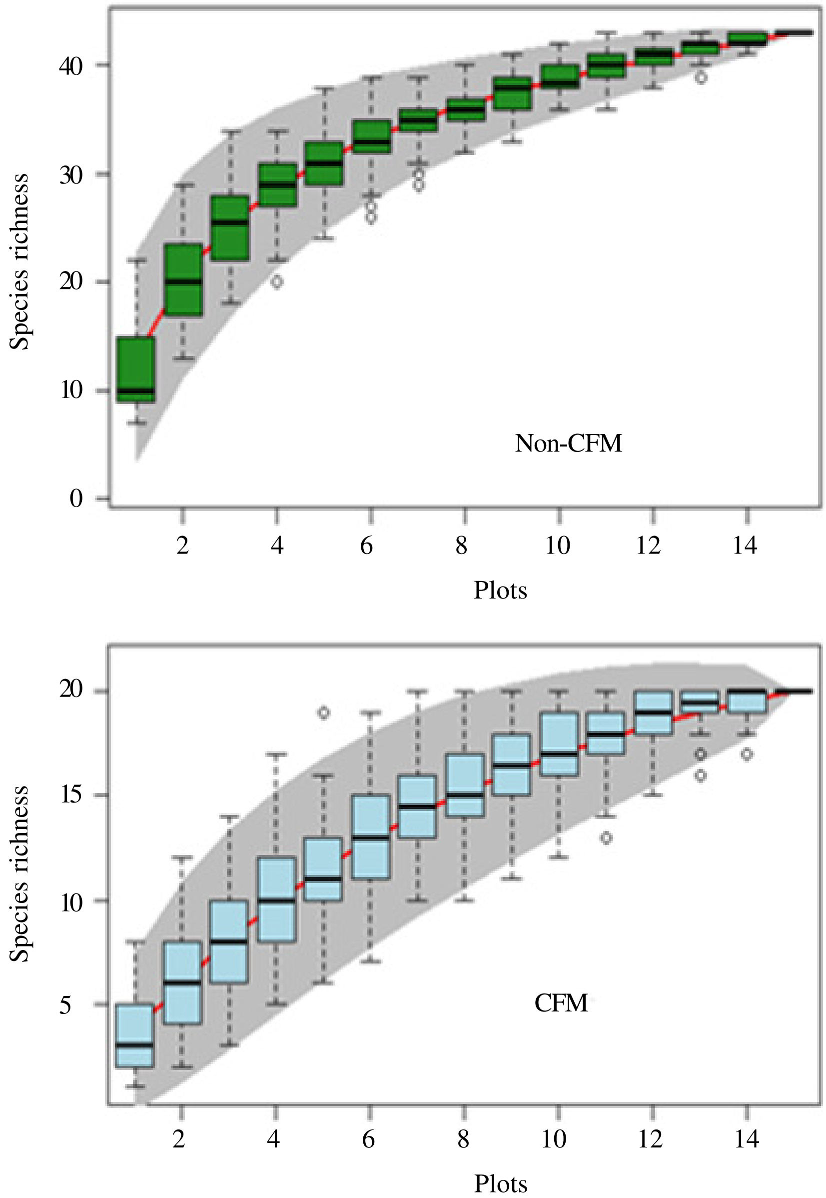

Figure 3. Species Accumulation Curves of Non-CFM and CFM sites.

Source of household income and access to forest products across the two sites
The study revealed that households in the community adjacent to CFM site (Buvunya) depended mainly on crop farming, livestock farming and, brick laying for income (Fig. 6(a)). On the other hand, the respondent households adjacent to Non-CFM site (Bulyansi) relied mostly on forest-based livelihood activities such as charcoaling, timber harvesting, brick laying, and also on crop farming but this at small scale (Fig. 6a). Overall, the proportion of households that derive their income from forest-based

Table 3. Floristic diversity and Structural parameters across the two sites; Non-CFM and CFM: mean values (m), coefficient of variation (CV, %) and ANOVA P-values

Parameters	Non-CFM		CFM		P-value
	m	cv (%)	m	cv (%)	
Floristic diversity					
Species Richness S, (Species)	13	38.48	4	53.05	0.000
Shannon Weiner Diversity H	2.09	16.57	0.97	32.09	0.000
Shannon Equitability, SE	0.83	4.39	0.85	19.99	0.802
Structural parameters					
Density D, (Stem/ha)	535	341.93	654.65	196.92	0.069
Mean Diameter D, (cm)	12.38	136.43	9.1	73.83	0.035
Basal area BA, (m^2/ha)	15.8	174.11	5.32	396	0.011

P-values are computed from log-transformed data (y = log (x + 1)) for the comparison of the 2 sites according to floristic diversity and structural parameters

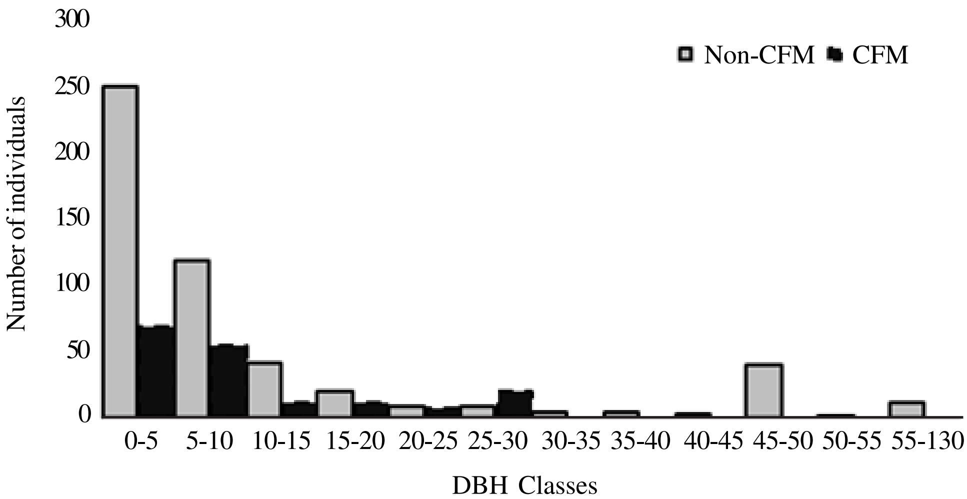

Figure 4. Overall Size Class Distribution of the two compartments under Non-CFM and CFM.

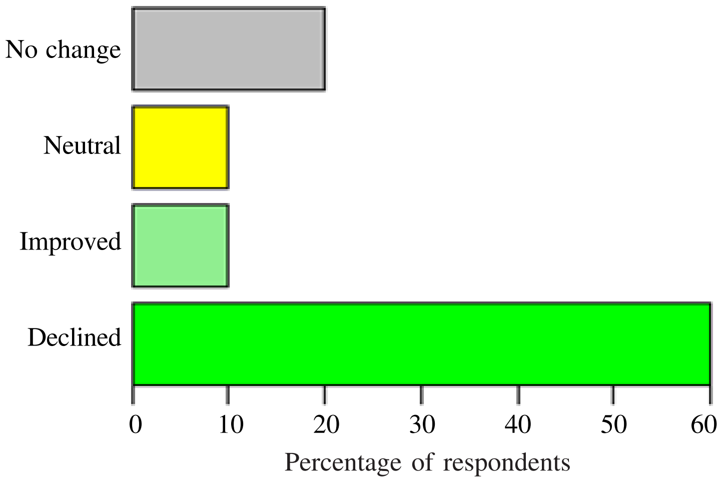

Figure 5. Perceived change in livelihoods by local community since establishment of CFM.

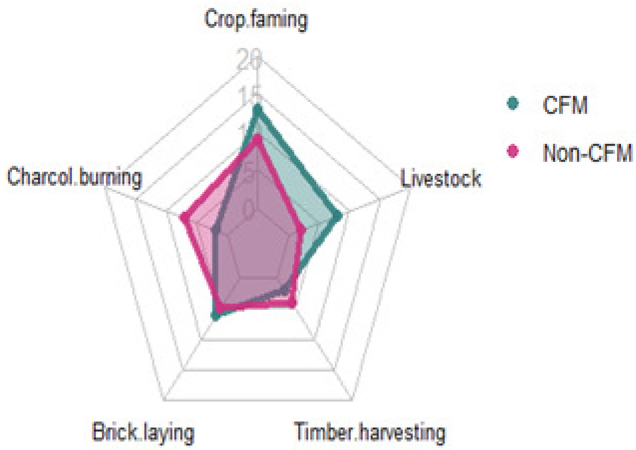

Figure 6(a). Variation in main source of household income across the two sites.

activities is higher in the Non-CFM site as compared to that of CFM site (Fig. 6a). Regarding the average monthly household incomes across the two sites, results revealed that communities adjacent to the Non-CFM site have higher number of households earning above Uganda Shillings.120,000 monthly and most of those adjacent to CFM site below Uganda Shillings.100,000. These findings suggest that the implementation of CFM approach has reduced the source of household participants to mostly non forest-based activities in terms of brick laying, crop farming and livestock farming which probably had led to the low monthly income recorded for local communities near the CFM site. Further, interview respondents stated that the perceived decrease in income was mostly due to new restrictions on forest resource use. For instance, one of the respondents from Buvunya village stated that: *"we are not allowed to access anything from the forest, life is becoming tough"*.

Across the two sites, the most used forest products accessed by the local community include wood charcoal, firewood, herbal medicine, timber, craft materials and forest fruits (Fig. 6b). The study showed that 80% of respondents from both sites CFM and Non-CFM have access to forest products while only 20% of the respondents have no access. Between the two sites, respondents from Bulyansi (Non-CFM site) have a better access of up to 90% of the total respondents and are able to access different forest products as compared to Buvunya (CFM site) where only 57% of the total respondents have access to the forest products. The interviewees in Buvunya reported that there is limited access to the forest resources and what they are allowed to exploit.

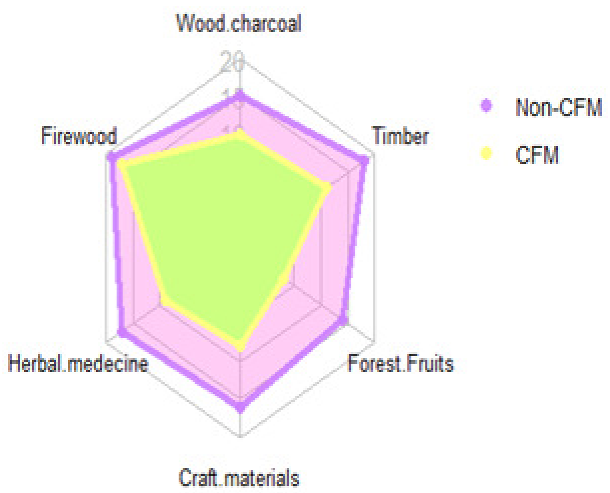

Figure 6(b). Variation in access to forest products across the two sites.

Social networking and employment opportunities

Majority of the respondents pointed out that there was an existence of social groups in the two forest adjacent villages and 29% of the household heads belonged to a social group linked to the forest. The community adjacent to CFM site benefited more (56%) from these social groups compared to the community adjacent to the Non-CFM (34%). The interviewees reported that the most benefits they obtained from these social groups included organizing burials, social interactions, improving businesses and employment opportunities. Most of the respondents from Non-CFM site belonged to less than two social groups whereas most of the respondents from CFM site belonged to more than two social groups.

With CFM in place, the community has shifted from totally depending on the forest to devising other means of living thus the increased involvement in social groups. On the other hand, sixteen percent of the respondents in both CFM and Non-CFM considered the forest as being important for provision of employment opportunities while 84% of the respondents from both sites have not obtained any employment from the forest. However, respondents from the 16% of community members adjacent to the site with CFM site arrangement, has obtained more employment from the forest while only 3% of the respondents under Non- CFM has obtained employment from the forest. CFM advocates that rights and responsibilities to manage forest resources be devolved to local communities settled in proximity. This explains why the community adjacent to CFM site obtained more employment opportunities as compared to that under Non-CFM site.

Discussion

The results of the study show that CFM site is less diverse compared to Non-CFM site. This could be explained by the fact that, there is a dominance of *Broussonetia papyrifera* commonly called paper mulberry which is the most dominant tree species with the highest value of IVI compared to other tree species recorded under CFM site. A previous study by Yamungu, (2020) in MCFR has pointed out that *Broussonetia papyrifera* consumes a lot of water, preventing other natural plants to get the necessary nutrients indispensable for their regeneration.

In terms of stand structure, both Non-CFM and CFM sites exhibited an inverted J shape which is an indicator of the regeneration of the forest. In comparison to Non-CFM size class distribution, site under CFM had less seedlings and saplings. According to Turyahabwe et al. (2013), the more trees found under Non-CFM site is probably due to the higher vulnerability of these compartments to extractive use thus more disturbances that creates favourable conditions for regeneration whereas, on the contrary, the large trees of CFM site closed the canopy and impeded regeneration of understorey tree species. However, our results contradict with the findings of Dereje and Mulugeta (2019) that revealed that CFM seems to have improved the conditions of the forest through enhanced natural regeneration. Similarly, studies of Phiri *et al*., (2012) and Kedir *et al*. (2018) showed that after CFM intervention, the forest cover improved.

Regarding the community livelihoods, the study showed that most of the local community are dependent on the forest resources. Majority of respondents adjacent to Non-CFM site are reliant on forest-based activities whereas, after the implementation of CFM, major income sources of respondents shift to agriculture-based activities. For instance, the respondents complained that fuelwood was not enough to meet the household needs. In Buvuma (CFM site) informants revealed that the quantities of resources they are permitted to access were so insufficient which makes them continue harvesting illegally. More so, the timetable set by the management about when to collect the resources was not suitable to women's daily programs. The two factors above partly contributed to the continued illegal harvesting of forest resources. Consistently, the study of Parren *et al*. (2001) in Cameroon showed that the implementation of CFM made the Bantu farmers activities shift to cultivation to sustain their food needs. While our results point out that CFM does not add much economic value (monetary) to the local population income, a study from Indonesia by Waridin *et al*. (2019) showed that CFM has helped to provide economic benefits to the surrounding population. Forest co-management can potentially improve household livelihoods by introducing profitable income generating activities; enhancing social capital; and development of human capital through training (Chinangwa *et al*., 2016).

Conclusion

This study assessed the impact of CFM on both forest status conditions and local community livelihoods. The findings indicated that the site under CFM has low diversity compared to the Non-CFM site. On the community livelihood side, CFM has unfortunately failed to improve the livelihood of the local adjacent communities. To survive, the local community has to rely mostly on non-forest activities such as livestock farming, bricklaying and such. From these findings, it can be concluded that CFM is not the model (approach) that will effectively manage forests in Uganda. CFM and Top-down approaches should be mixed to improve forest status and local community livelihoods.

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